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Westinghouse

THE
WESTINGHOUSE
ELECTRIC COMPANY,
SOLE PROPRIETOR
OF THE
GAULARD-GIBBS SYSTEM
OF
Electrical Distribution.

Patented October 26, 1886.



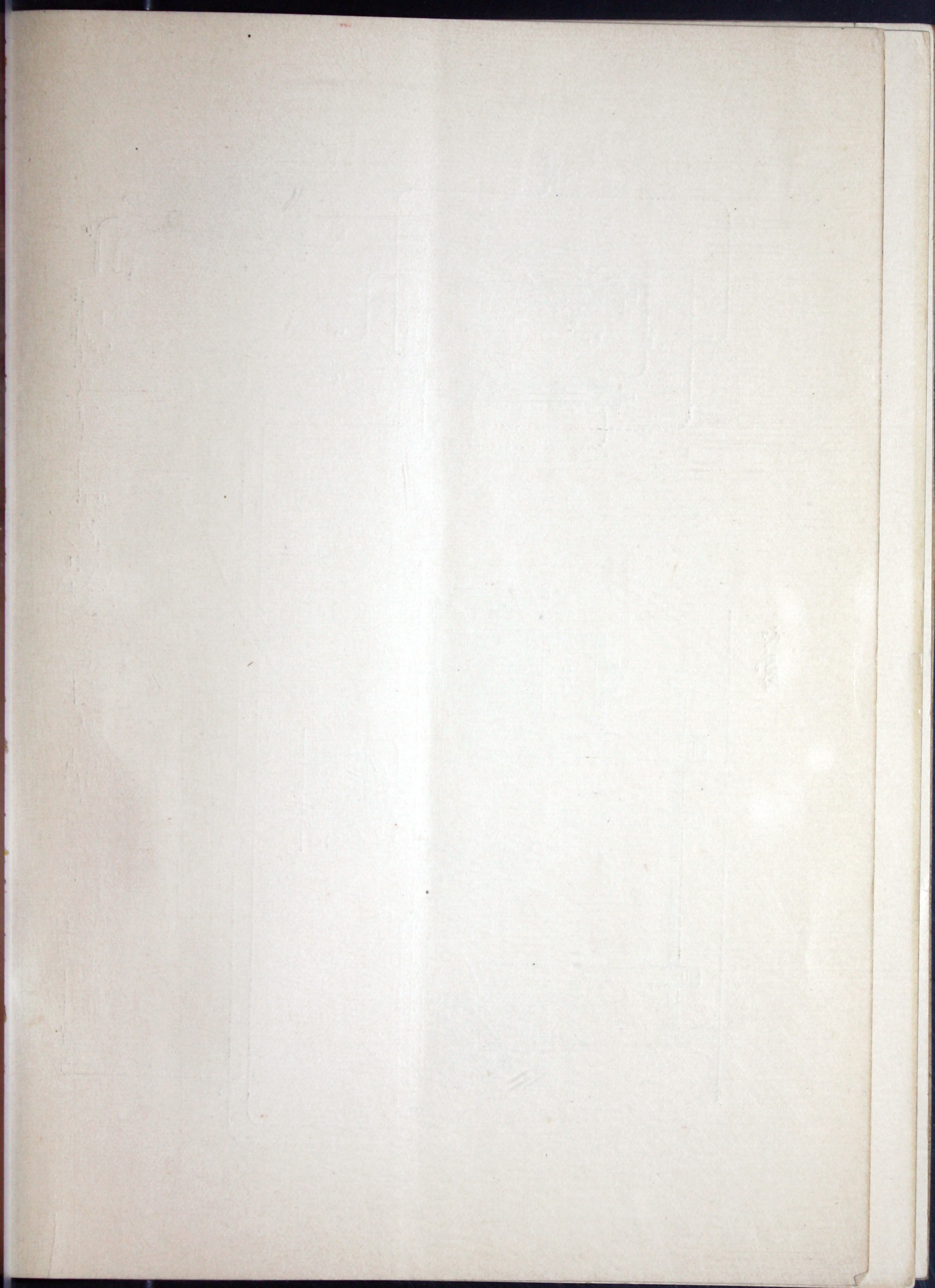


Fig. 1.

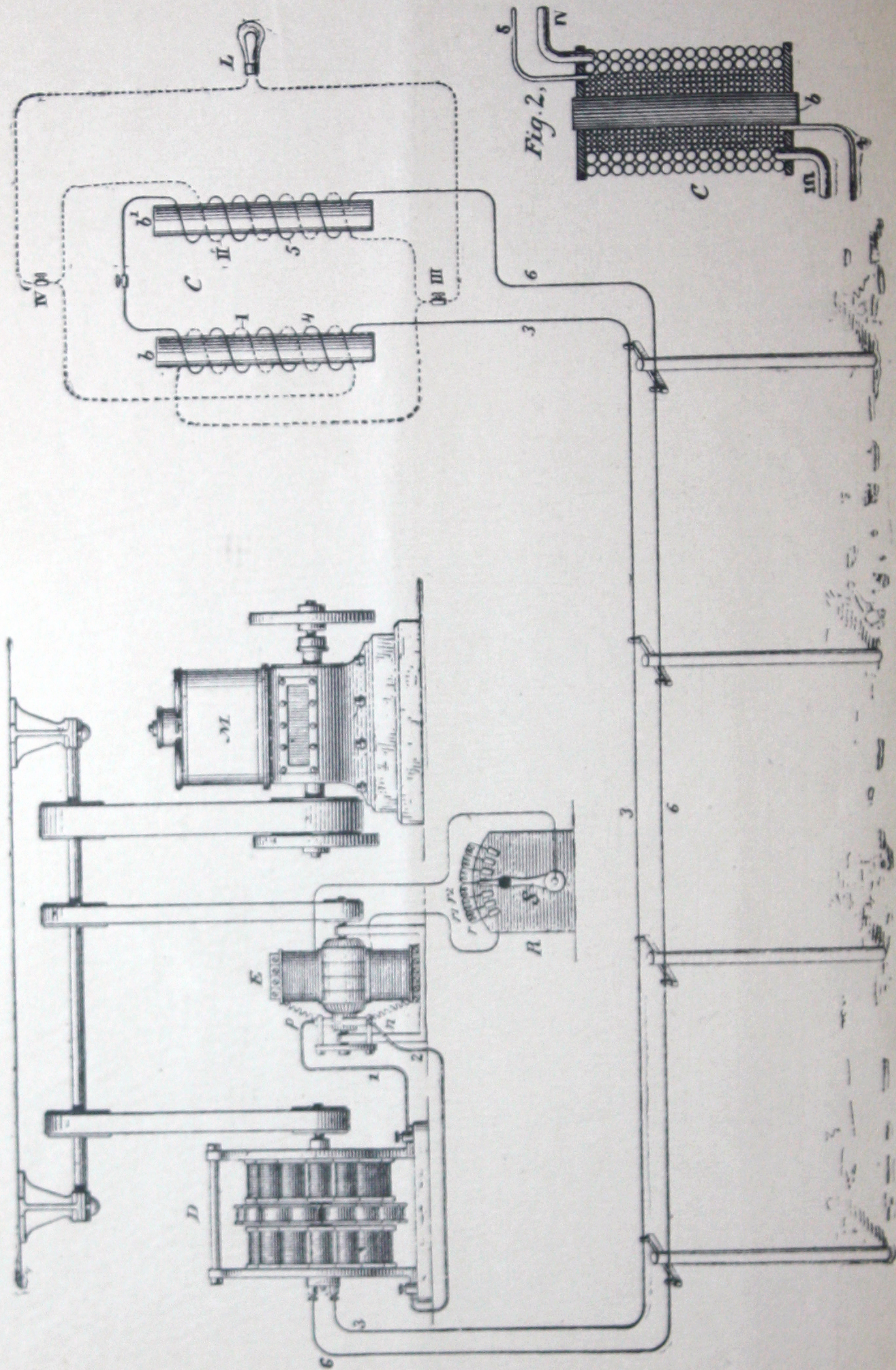
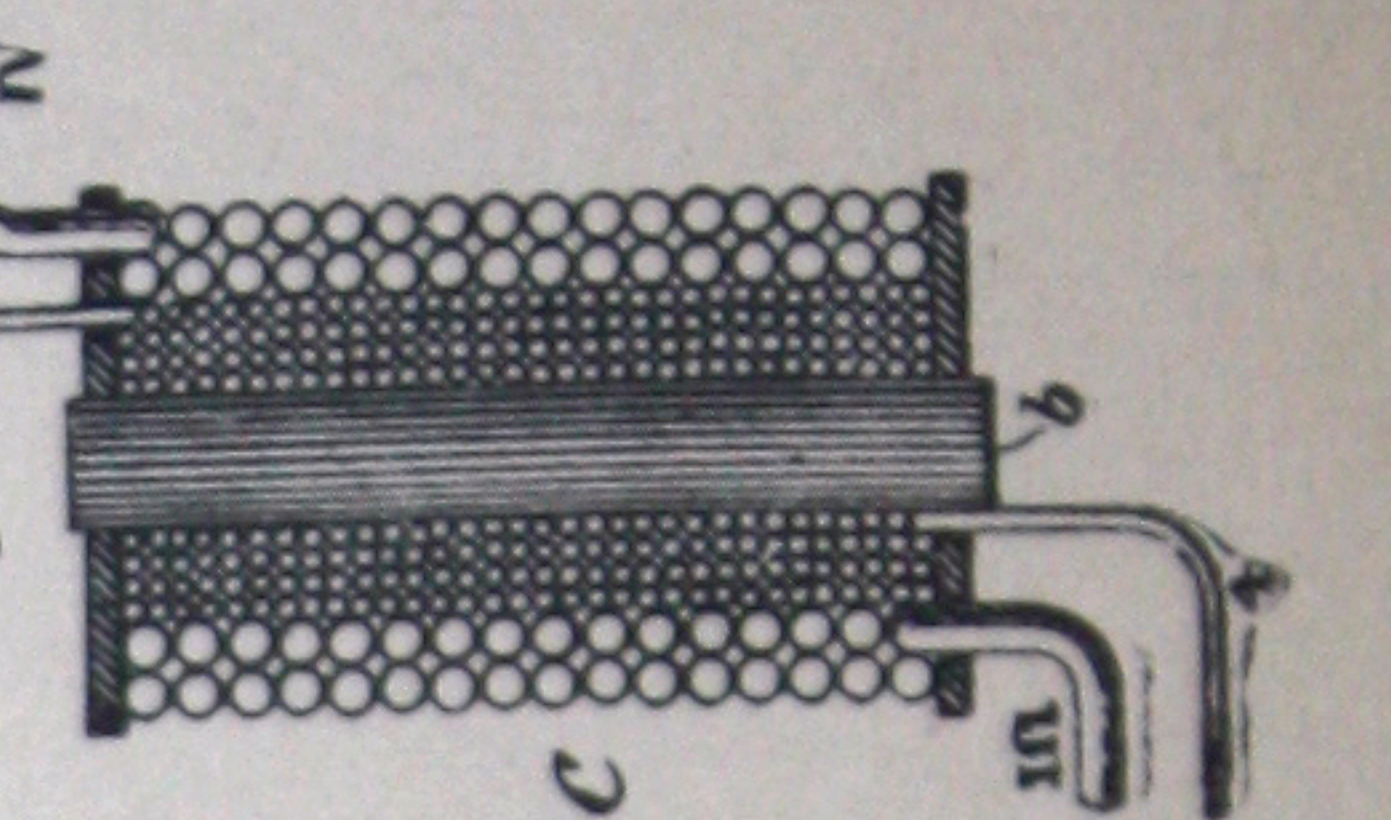
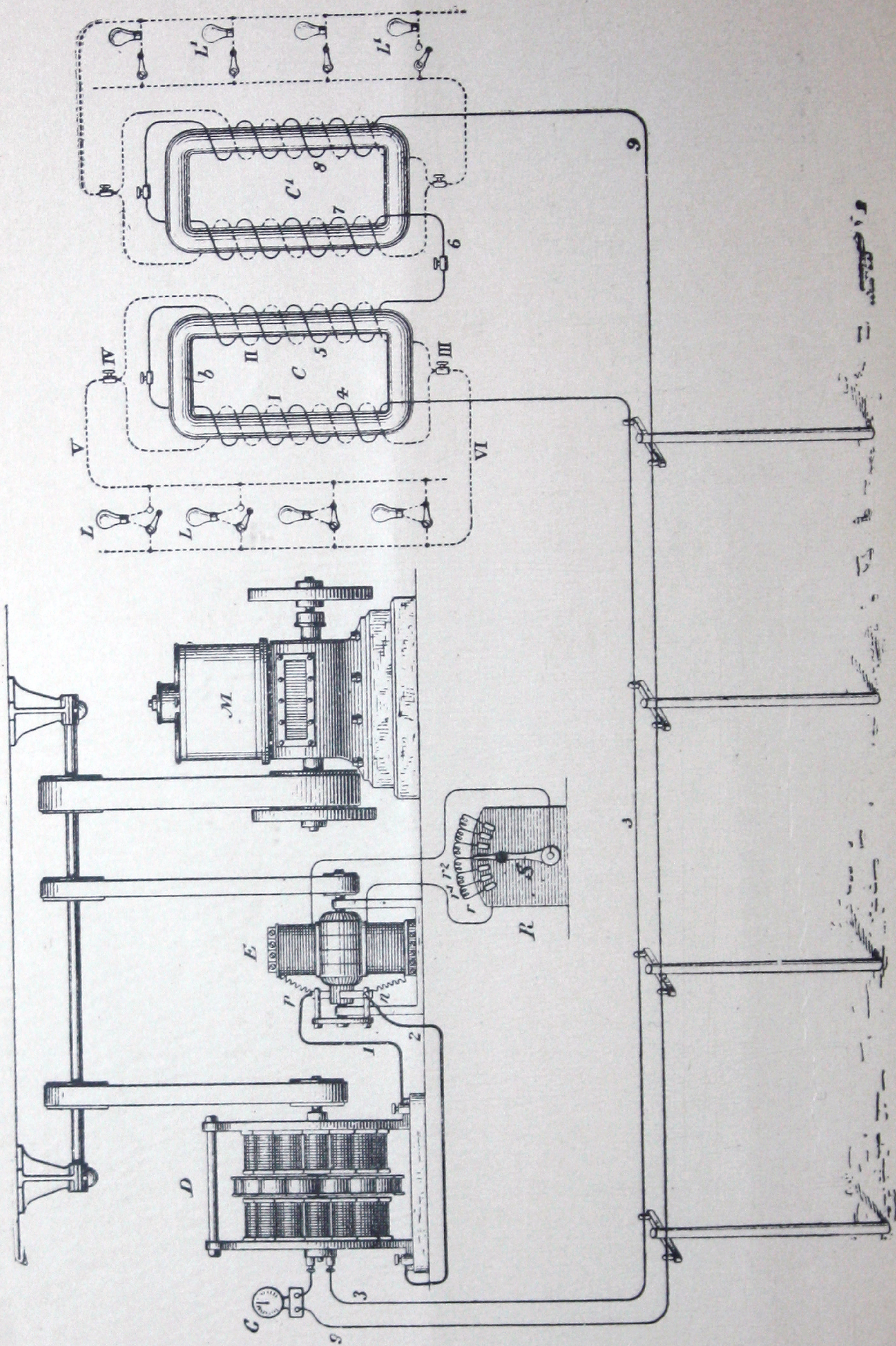


Fig. 2.



10 10-B6490 TCF

Fig. 3.



The Westinghouse Electric Co.

United States Patent Office.

LUCIEN GAULARD AND JOHN D. GIBBS, OF THE COUNTY OF MIDDLESEX, ENGLAND, ASSIGNORS TO GEORGE WESTINGHOUSE, JR., OF PITTSBURGH, PENN.

SYSTEM OF ELECTRIC DISTRIBUTION.

Specification forming part of Letters Patent, No. 351,589, dated October 26, 1886.

Application filed March 6, 1886. Serial No. 194,229. (No model.)

To all whom it may concern :

BE IT KNOWN, That we, Lucien Gaulard, a citizen of the republic of France, and John Dixon Gibbs, a subject of the Queen of Great Britain, both of the county of Middlesex, England, have jointly invented certain new and useful Improvements in Methods and Apparatus for the Distribution and Conversion of Electric Energy, of which the following is a specification :—

Our invention relates to the distribution of electrical energy for industrial purposes, and it consists in an improved art or method, and an organization of apparatus whereby the same is carried into effect, by means of which we are enabled to transmit from a central or supply station through a main conductor a primary electric current of comparatively small quantity but of high potential, and at a point or points more or less distant where the said electric energy is to be utilized, to transfer the energy residing in such primary current of high potential, into one or more secondary currents of lower potential but of greater quantity. To this end, the invention comprises certain combinations of apparatus having an organization and mode of operation particularly adapted to effect such transference of electric energy.

By means of our improved method and apparatus we are

enabled to convey a useful quantity of electric energy to a much greater distance than has heretofore been practicable, while the cost of the necessary plant for electric lighting and other analogous purposes, especially that of the main electrical conductors, is very materially diminished.

The accompanying drawings represent an organization of apparatus which we have found to be well adapted for carrying out our invention.

Figure 1 is a theoretical plan showing the general principle of the apparatus, figure 2 is a transverse vertical section of one form of converter, and figure 3 is a diagram showing one plan of arranging the apparatus when the transference of energy is to be effected at more than one point.

In the drawing, D represents a dynamo-electric generator of suitable construction, organized for the production in the main line of alternating currents, that is to say, successive electric currents or pulsations alternately of positive and negative polarity and of equal potential and duration. We have found by experiment that the dynamo-electric machine of Alteneck, described in United States Letters Patent No. 234,353, of November 9th, 1880, is well adapted for our purpose; but we do not desire to confine ourselves to any particular construction of generators for setting up alternating currents in the line, as there are many forms of these known and used which will serve sufficiently well.

In order to operate a dynamo-electric machine for the production of alternate currents, it is necessary to provide some means for maintaining its magnetic field. This may be accomplished by a separate current derived from an independent dynamo machine, technically termed the "exciter." Such independent exciter is shown in the drawing at E. It may be an ordinary direct current dynamo machine, of any suitable construction. The current of the exciter E is conducted from its terminals *p, p*, by means of wires 1 and 2, to and through the field-magnet helices of the main dynamo or generator D.

In order to vary when required the electromotive force of the generator D, it is convenient to effect a corresponding variation in the strength of the current in the field produced by the exciter E. This may be done in the case of a shunt-wound exciter, by an adjustable resistance inserted in the field of the exciter. We have shown this plan in the drawings. R is a rheostat composed of a

series of graduated resistance coils r, r^1, r^2 , etc. A movable contact-arm or other equivalent devices is provided, by means of which the current for maintaining the field produced by the exciter E may conveniently be regulated. The same result may be reached in other well-known ways. The power for operating the main dynamo D, as well as the exciter E, is furnished by a suitable steam engine or other convenient motor M.

At a point where the electric current is to be utilized for any suitable purpose, as for instance, in one or more incandescent electric lamps, we place one or more secondary generators or converters, as shown at C in figure 1. The general principle of our secondary generator is analagous to that of the well-known inductorium or induction coil, with this exception, that while the induction coil has heretofore usually been employed to transfer electric energy from currents of low potential and great quantity into currents of high potential and small quantity, the function of the secondary generator or converter as applied in our invention is precisely the reverse of this, namely, to transfer electric energy from currents of high potential to currents of low potential and increased quantity. We have constructed converters for effecting this result in a variety of forms, all of which involve the same principle. In order that this principle may be better understood, we will describe the construction and mode of operation of a simple form of the converter which we have shown at C in figure 1. Two iron cores b, b^1 , are preferably built up from a large number of small soft iron wires, insulated from each other and mechanically secured together in a solid bundle. It is usually preferable to unite the ends of the cores so that they will become magnetically continuous. In figure 3 for example, we have shown the cores in the form of a rectangle; but the core or cores may be straight cylinders, or closed figures of oval, annular, horse-shoe or other shape, this being merely a matter of convenience in construction or economy in operation, but involving no change of principle. Around the cores b, b^1 , the primary electric conductors 4 and 5 are disposed helically in the manner shown in the drawing, which, however, is intended to represent the arrangement of these conductors in a symbolical or typical manner only, the actual construction being preferably similar to that shown in figure 2, hereinafter to be described. By inspection of the drawing it will be seen that one conductor, 4, is coiled upon the left-hand

portion of the core, and the other similar conductor, 5, upon the right hand portion, and the two conductors 4 and 5 are then connected at their adjacent ends, that a current may traverse them in series and thus develop magnetism in the iron cores b , b^1 , so as to establish a magnetic field surrounding or enveloping said cores and adjacent thereto. The secondary conductors I. and II. are disposed in precisely the same manner around the cores b and b^1 , and within the same magnetic field. In the particular arrangement shown in figures 1 and 3 of the drawing, each convolution of the secondary conductor is interposed between two adjacent convolutions of the primary conductor, so that the number of convolutions as well as their mean distance from the axis of the core is the same. Experience indicates that the more nearly the last mentioned relation is preserved, the higher will be the efficiency of the apparatus. The relative disposition of the primary and secondary helices may otherwise be greatly varied without material change in the result; for example, one may be superposed upon the other as in figure 2, or the two may be placed upon different parts of the same core or cores, according to circumstances. It is to be observed that the secondary conductors shown in figure 1 of the drawings are not united in series like the primary conductors, but their ends are joined together as shown at III. and IV., in parallel or multiple arc, and from the last named junction points of the secondary, the conductors V. and VI. are led to an electric lamp or other translating device L by which the circuit is completed.

We will now describe the mode of operation of the apparatus. When the dynamo-electric generator D is set in operation, a rapid succession of alternating positive and negative currents or pulsations of equal potential and duration, technically termed an alternating current, is set up in the main or primary conductor, the path of which may be traced in figure 1 as follows:—From one terminal of the generator D by the line conductor 3 to the primary conductor 4, 5 of the secondary generator C, thence returning by the line conductor 6 to the opposite terminal of the generator. The alternate current proceeding from the primary generator D, by its inductive action in the secondary generator C, creates a magnetic field of alternate polarity, and this alternation of the magnetism of the field, in accordance with a well-known law, generates by inductive reaction an alternate current in the closed

circuit of a secondary conductor situated within it. This secondary current may be utilized for electric lighting or other purposes in the same manner that primary currents ordinarily are, by including proper translating devices in said secondary circuit.

The most important and characteristic feature of our invention is that which renders it possible to make use of alternating and equal positive and negative currents of moderate quantity but of very high potential, in the primary or main line circuit, and to convert these into secondary or induced currents of much greater quantity but of corresponding lower potential at the place of consumption, which secondary currents are employed to do the required work. This is a result, the attainment of which is of the utmost importance in the art of electrical distribution, as it renders practicable the employment of insulated main conductors, of comparatively small size and moderate cost, for the transmission of large amounts of energy to great distances.

We will now explain the means by which this increase of quantity and reduction of potential in the secondary circuit is effected. Let it be assumed that we have an electric lamp, as L in figure 1, so constructed as to work at maximum efficiency when rendered luminous by an electric current of 1 ampere. Let it also be assumed that, for economical or other reasons, it is desired to employ an alternate current of 0.5 ampere only in the primary circuit. The necessary increase in the quantity of the secondary current will, in such case, be effected by the apparatus when arranged precisely as shown in the figure, for as the primary conductor of the converter C is connected in series, while the secondary conductor (with an equal number of convolutions situated in the same magnetic field) is arranged with one-half its convolutions in multiple arc with the other half, the result will be precisely the same as if the actual number of convolutions of the secondary conductor were only half as many as those of the primary. The total resistance of the secondary conductor when thus connected, is obviously only one-fourth as great as that of the primary, the secondary being double the cross-section, and virtually only one half the length of the primary.

When an electric current of alternating polarity is caused to pass through the primary conductor of the converter C—figure 1—it

creates by electro-magnetic induction a magnetic field, the intensity of which, within the ordinary limits of working, is proportional to the current (expressed in amperes) passing through the conductor. Each alternation so produced in the magnetism of the field tends to set up a definite electromotive force in each separate convolution of any conductor traversing the field. In the primary conductor this electromotive force opposes itself temporarily to the primary or magnetizing current, but as it is of inferior and rapidly decreasing potential, it acts merely to delay, and not to prevent, the magnetization of the field. An approximately equal electromotive force is at the same time set up in each convolution of the secondary conductor, but, as the latter (in the present example) makes only half the number of convolutions within the field, the total electromotive force of the secondary current will be only one-half that of the primary current. Inasmuch, however, as the value of any current is expressed by the quotient of the electromotive force divided by the resistance, and as the resistance of the secondary coil is only one-fourth that of the primary, the actual number of amperes in the secondary current will be approximately twice as many as in the primary current. Strictly speaking, however, the inductive action may be said to be determined, not by the number of convolutions but by the extent of conductor, measured in linear units, which is in inductive relation to the magnetic field, assuming the lines of force in such field to be uniformly distributed. In order to produce a proper result, it is preferable that the resistance offered by that portion of the linear conductor in the magnetic field which is traversed by the primary current, shall exceed the resistance of the conductor in the same field traversed by the secondary current, in an inverse ratio to the increase in current strength or reduction of potential which it is desired to effect.

Any required number of converters, of the general construction described, may have their primary circuits united with, or included in, the conductors leading from the primary generator. The manner of connecting such converters, whether in series, multiple arc, multiple series, or otherwise, will be understood by those skilled in the art to which our invention relates, without the necessity of further explanation. One arrangement, however, indicated in figure 3, in which a second converter, C 1, is placed in circuit, provided with a secondary conductor and an

independent group of lamps. The primary current traverses the circuit 3, 4, 5, 6, 7, 8, 9, passing through the primary wires of both converters, and the separate groups of lamps are shown at L and L 1. We do not herein claim the connection of the converters in the line, in any other arrangement than we have illustrated in the drawings.

It must not be forgotten, however, that the consumption of energy in the main or primary circuit will, in all cases, bear a certain definite ratio to the work which is being done, or at least to the resistance which is offered at any given time in the secondary circuits of the converters, whether one or many. The attendant at the generator, by means of an electro-dynamometer or other suitable current indicator, G—figure 3—can readily detect any change in the strength of the current due to variations in the consumption, and, by moving the arm s, can correspondingly raise or lower the electromotive force of the generator D, so as to bring the current back to its normal strength.

The converter C may be constructed in various ways. We have attained excellent results by constructing it in the manner more particularly shown and described in prior United States patents, Nos. 297,924 of April 29th, 1884, and 316,354 of April 21st, 1885. Another form, which gives excellent results in practice, is shown in figure 2, in which *b* is a core formed of a bundle of iron wires, around which the primary wire 4 is coiled in a helix of the ordinary form. The helix of the secondary wire III, IV., is superposed upon that of the primary, in the manner shown. The sectional area of the secondary wire is here shown as four times that of the primary, while the number of convolutions is only one-fourth as great. We nevertheless do not desire to confine ourselves to any particular construction of the converter, as this is quite immaterial so long as the essential principles which we have hereinbefore set forth are not departed from.

We claim as our invention:—

1. The hereinbefore-described art or method of electrical distribution and conversion, which consists in establishing in a closed electric circuit, a current of alternate and equal positive and negative potential, producing by the influence of such current an inductive field of alternate polarity, and thereby inducing in translating devices situated in an independent closed circuit traversing such field, a similar alternating secondary current

of greater quantity and less potential than the originating or producing current.

2. In a system of electrical distribution, an inductorium or converter, in which the length of that portion of the conductor traversed by the primary current within the magnetic field created by itself, exceeds the length within the same field of the conductor traversed by the secondary current, in combination with a dynamo-electric generator producing alternating electric currents or pulsations of equal potential and duration, and translating devices actuated by said secondary current.

3. In a system of electrical distribution, an inductorium or converter, in which the resistance of that portion of the conductor traversed by the primary current within the magnetic field created by itself, exceeds the resistance of that portion of the conductor traversed by the secondary current which lies within said field, in combination with a dynamo-electric generator producing alternating currents or pulsations of equal potential and duration, and translating devices actuated by said secondary current.

4. In a system of electrical distribution, a dynamo-electric machine, organized for the production of alternate positive and negative currents, equal to each other in potential and duration, in combination with the primary circuit of an inductorium or converter organized to induce in its secondary circuit alternating currents of lower potential and greater quantity than those of the primary circuit, and one or more translating devices actuated by said secondary currents.

5. In a system of electrical distribution, the combination of an inductorium or converter, having its primary and secondary circuits constantly closed, a dynamo-electric generator for producing alternating currents of equal potential and duration included in said closed primary circuit, and one or more translating devices included in said closed secondary circuit, substantially as set forth.

[NOTE.—The claims of this patent were refused by the Primary Examiner on the ground of lack of patentable novelty, but were allowed on appeal to the Board of Examiners in Chief. The argument in behalf of the applicants and the decision affirming the novelty and patentability of the invention are herewith given in full.]

United States Patent Office.

BEFORE THE BOARD OF EXAMINERS-IN-CHIEF, ON APPEAL.

In the Matter of the Application of LUCIEN GAULARD and JOHN DIXON GIBBS, for Letters Patent for an Improvement in Apparatus for the Conversion and Distribution of Electricity.

BRIEF IN BEHALF OF APPLICANTS.

The application, having been rejected by the Primary Examiner on the ground that no invention is shown in view of the references cited, now comes before the Board of Examiners-in-Chief on appeal.

The invention which is sought to be patented relates to an improved method of distributing electric currents for illuminating purposes, and particularly to an improved apparatus whereby said method is practically carried out.

The ordinary systems of incandescent electric lighting, now in general use in this country and abroad, consist essentially of three parts:—

- (1) A dynamo-electric machine producing a constant current.
- (2) One or more lamps, each composed of a carbon filament enclosed in an exhausted glass globe, and rendered incandescent by the electric current from the dynamo; and
- (3) Conductors for conveying the current from the dynamo to the lamp.

The general introduction of this system for the purpose of lighting towns and villages from central stations, in competition with gas, has heretofore been restricted within comparatively narrow limits by the enormous cost of the necessary conductors. This objection to the present system is inherent and unavoidable.

Professor George Forbes, of London, has shown that with the

ordinary Edison lamp of 100 volts, a plant of 60,000 lamps situated within a radius of 2,100 feet (less than half a mile) would require a quantity of copper in the conductors of the value of \$4,277,700, or \$71.30 per lamp. With 100,000 such lamps, over a ton of copper is required for every yard of distance on the multiple-arc system (*Cantor Lectures, Electrician and Electrical Engineer, IV.*, 222, 223). It is true that if it were possible to work the lamps at a considerably higher potential than 100 volts, this enormous expense could be materially reduced, but thus far it has not been found possible to do so.

To overcome this formidable obstacle to the general introduction of house-to-house electric lighting is the object of the applicants' invention, and we contend that if we can show that they have actually done this on a commercial scale, that they were the first to do it, and that they have accomplished such a result by the aid of a method of operation, and of a combination of apparatus never before known or used, we have made out our case, and are entitled to the grant of a patent.

We will first consider the general character of the invention.

Each incandescent lamp connected with a source of electricity, when in operation, absorbs a certain definite amount of mechanical energy, ordinarily about one-eighth of a horse-power. This energy may be conveyed over a conductor, either in the form of an electric current of low potential and great quantity, or in the form of a current of higher potential and correspondingly less quantity. The size and, consequently, the cost of the conductor required, depends wholly on the *quantity* of current to be conveyed, and not at all upon its potential. Hence, it is theoretically possible to convey any required amount of energy over a given conductor by raising the potential to a sufficient degree. But the potential in the ordinary system of distribution is practically limited to that which the lamp, in the present state of the art, will withstand, namely, about 100 volts, and hence the quantity can only be increased by increasing the weight of copper in the conductor in proportion to the distance, and also in proportion to the number of lamps to be fed. Hence the enormous and prohibitory cost which is entailed when the number of lamps, or their geographical distance from the source of electricity, exceeds a certain well-defined and narrow limit.

The invention of the applicants is simply this: They transmit

over the line a current of very high potential, eight or ten or more times as high as that ordinarily used, making use of a comparatively thin wire, and at the point of consumption they convert this high potential current into an equivalent current of low potential and great quantity, which is adapted to the requirements of an ordinary incandescent lamp of 100 volts. To accomplish this, we find it necessary to use an alternate instead of a direct current on the main line, and a converter (which is a modification of the well-known induction coil) for effecting the desired change in the character of the current at the point of consumption.

I.

The utility of the invention raises a presumption of its novelty.

The claims presented in the application are for a combination consisting of certain specific elements acting upon each other to produce a certain result, neither the utility nor the novelty of which result is denied by the Examiner. All the elements of the combination, separately considered, are admitted to be old in view of the references cited, but the combination as a complete whole, capable of producing the particular result sought for, is, as we contend, not present in any of them. Not one of the references cited shows an organization capable of producing the same result, except by introducing something from one of the others. Neither an enlargement of the old apparatus, nor a modification of its proportions, will do it. There must be selection from the different organizations, there must be adaptation, there must be reorganization, in order that the new result may be effected. The Examiner holds that this does not amount to invention. But when a result is reached, a result not merely different in degree, but different in kind; a result recognized as new, and admitted to be of great industrial value, namely, the working of incandescent lamps at a distance of 25 miles or more when one-half mile had before been the limit, it affords the strongest possible presumption that invention, and invention alone, could have produced such a result.

Webster, in his *Subject-matter of Patents*, p. 30, says:—

“The utility of the change, as ascertained by its consequences,

is the real practical test of the sufficiency of the invention, and since the one cannot exist without the other, the existence of the one may be presumed as proof of the existence of the other. Where the utility is proved to exist in any degree, a sufficiency of invention to support the patent must be presumed."

Justice BRADLEY, in *Loom Co. vs. Higgins* (105 U. S., 591), said:—

"It may also be laid down as a general rule, though perhaps not an invariable one, that if a new combination and arrangement of known elements produces a new and beneficial result never attained before, it is evidence of invention." See also

Terry Clock Co. vs. New Haven Clock Co.,
17 O. G., 909.

Wallace vs. Noyes, 23 O. G., 435.

Ward vs. Plow Co., 14 Fed. Rep., 696.

Smith vs. Dental Vulcanite Co., 11 O. G.,
246.

Goodyear Co. vs. Willis, 7 O. G., 41.

In *Bruce vs. Marder* (22 O. G., 1039), it was held that the fact that an invention is of great utility, and has gone largely into use, goes to show that the inventor discovered and put to use something which others skilled in the art had overlooked, and something which very probably would have been found out before if ordinary skill in that art could have discovered it.

What are the facts as to the utility of this invention?

The first experiment on a commercial scale with the apparatus was made on the Metropolitan Railway in London in 1883. The circuit was a No. 8 copper wire, and four separate railway stations were lighted from one dynamo, by means of 100 Swan incandescent lamps and 6 arc lamps, each equivalent to 7 incandescent lamps placed at different points.

In September, 1884, a plant was exhibited at the Turin Exhibition, a report of which by M. Tresca is in vol. xiii., p. 529 of the London *Electrician*, on which occasion 24 Swan incandescent lamps of 100 volts each were maintained in operation at an actual geographical distance of 25 miles from the generator, over a wire 4 millimetres in diameter, the whole circuit being 50 miles in length. We assert that an equal number of lamps had never before been operated at a distance so great as even *one mile* from

the generator, and that it was a result for the first time rendered possible by means of the invention for which we now seek a patent.

There is at this moment a commercial plant in operation in London, from a central station, over a line over six miles in length, which was supplying in February, 1886, a total number of 1,434 incandescent and 2 arc lamps, distributed over a large area, a number which was being added to almost daily.

We might cite a number of other applications to show the great utility of this invention, but it seems unnecessary. As to the possibilities of the invention, Professor Forbes, in a paper read before the Society of Arts (*Electrician and Electrical Engineer*, vol. v., p. 140), says that by its means a wire of one square inch section will carry current enough to supply 100,000 16-candle incandescent lamps.

II.

The novelty of an invention is not negatived by the fact that every separate part of the organization is old.

This principle is so familiar that it is hardly necessary to discuss it; the mere statement ought to be sufficient.

The Examiner, however, contends that nothing is made known in these two applications, which was not already within the knowledge of the public. In support of this position he cites the following references:

U. S. Patent of L Maiche, No. 243,454.

U. S. Patent of T. A. Edison, No. 278,418.

Description of Apparatus of Spottiswoode
(*London Engineer*, August 11, 1882, p. 102).

Maiche shows an electric generator (which is a voltaic battery), a circuit-breaker which alternately opens and closes the circuit of the battery, a converter for transforming the intermittent current of low potential derived from the battery into an alternating current of high potential in the line, a second converter for transforming the alternating high potential current of the line into an alternating low potential consumption current, which

latter is employed to set up vibrations in an electro-magnet for telegraphic purposes.

If it were true that applicants had done nothing more than to substitute one or more electric lamps for the receiving electro-magnet of Maiche and a dynamo-electric machine for the actuating battery employed by him, then Maiche's organization might perhaps constitute a sufficient anticipation.

Suppose that this were done on a scale large enough for electric lighting. Two results would follow: First, the alternate pulsations occurring at the interruption of the primary circuit would be at least double the potential of those at the completion of the circuit, the alternate pulsations in the lamp would be very unequal, by reason of which it would shine with an intolerable vibratory flickering; and, second, no interrupting circuit breaker could possibly withstand the sparking which would take place with the powerful current, and which would fuse the contact points in an instant.

Applicants therefore employ an *alternating generator* which does not interrupt the circuit and which supplies alternate and equal currents, thereby avoiding both these fatal objections.

Edison's apparatus (the second reference) is objectionable and impracticable for the same reasons. It employs a continuous primary current of one polarity and of high potential, which is converted into an alternate current at the place of consumption by a rotary commutator, and then by induction is transformed into a secondary alternate current of lower potential, and this by another commutator is redressed and fed to the lamps. It will be observed that applicants' claims carefully distinguish their device from Edison's as being adapted to produce alternate and equal secondary currents from an alternate primary current, while Edison's—assuming it to be operative—is only adapted to produce intermittent direct secondary currents from a continuous direct primary current.

Spottiswoode's apparatus (the third reference) produces, by means of a converter, a current of high potential and equal alternations from a current of low potential and equal alternations. That is, if applied to electric lighting, Spottiswoode's method would aggravate and increase the very difficulty which it is the specific object of applicants' invention to remove. It would increase the potential and diminish the quantity of the

secondary current, whereas the very essence of the present invention, and the point in which all its value consists, is that the secondary current shall be of lower potential and greater volume than the primary current.

III.

The novelty of an invention is not impeached by an organization fundamentally incapable of the function which that invention is designed to perform, even though the prior thing was mechanically similar thereto.

In *Morey vs. Lockwood* (18 Wall., 230), which was a suit alleging infringement of the well-known soft rubber syringe, a prior device was set up exactly like it, except that the central part was a soft rubber cylinder with metal heads, instead of a soft rubber bulb. Owing to the difficulty of compressing the cylinder, the device was inconvenient and of little value, and few were ever sold. Hence the Supreme Court held that it did not anticipate the patent.

Not one of the apparatuses cited as references by the Examiner is capable of performing the functions which are performed by applicants' combination, and this is by reason of the different manner in which the elements of the latter are combined.

If an invention consisting of a new combination of old elements is to be refused a patent because some of its parts are found in one old apparatus and the rest in another, notwithstanding that a different result is produced, the novelty and utility of which is not denied, then it would appear that a majority of the most useful and meritorious inventions which are likely to be made in the future will be liable to meet the same fate.

We contend that the decision of the principal Examiner is erroneous, and that it should be overruled by your honorable Board, and a patent ordered to be issued to the applicants.

POPE & EDGECOMB,
Attorneys for Applicants.

United States Patent Office.

BEFORE THE BOARD OF EXAMINERS-IN-CHIEF ON APPEAL.

Application of GAULARD & GIBBS for a patent for an Improvement in Apparatus for the Distribution and Conversion of Electric Currents, filed March 6, 1886. Serial No. 194,229.

MESSRS POPE & EDGEComb for applicants.

The claims appealed are :

1. In a system of electrical distribution, a secondary generator or inductorium, in which the length of that portion of the conductor traversed by the primary current within the magnetic field created by itself, exceeds the length within the same field of the conductor traversed by the secondary current, in combination with a dynamo-electric generator producing alternating electric currents or pulsations of equal potential and duration.

2. In a system of electrical distribution, a secondary generator or inductorium, in which the resistance of that portion of the conductor traversed by the primary current within the magnetic field created by itself exceeds the resistance of that portion of the conductor traversed by the secondary current which lies within said field, in combination with a dynamo-electric generator producing alternating currents or pulsations of equal potential and duration.

3. In a system of electrical distribution, a secondary generator or inductorium in which the resistance within the magnetic field of the conductor traversed by the primary current exceeds the resistance within the same field of the conductor traversed by the secondary current, in combination with a dynamo-electric generator for producing alternating electric currents or pulsations of equal potential and duration in the primary circuit, and one or more translating devices for utilizing alternate currents in the secondary circuit of said inductorium.

“4. In a system of electrical distribution, the combination of a main circuit conveying an alternating current of high potential, a local or consumption circuit conveying an alternating current of low potential, and an intermediate inductive apparatus for transferring electric energy from the main to the consumption circuit, and at the same time reducing the potential of the secondary current below that of the primary.”

5. In a system of electrical distribution, the combination of a secondary generator or inductorium, having its primary and secondary circuits constantly closed, a dynamo-electric generator

for producing alternating currents of equal potential and duration included in said closed primary circuit, and one or more translating devices included in said closed secondary circuit, substantially as set forth.

The references are patents to Maiche, June 28, 1881, No. 243,454; Edison, May 29, 1883, No. 278,418; and publication of Spottiswoode (London *Engineer*, August 11, 1882, page 102).

The invention relates to an improved system and apparatus for distributing electrical currents, primarily for electric lighting, on the incandescent plan for long distances over medium sized conductors; a thing hitherto practically unaccomplished. The importance of the invention, therefore, is to be measured by the novelty and magnitude of the results achieved rather than by the apparent simplicity of the means adopted.

It is not claimed by applicants that they have invented any new electrical element or appliance. They simply claim to have combined certain elements well known to electricians, such as electro-generators, circuits, induction apparatus, translating devices, etc., in a novel way, to produce new and important results. This is the measure of invention if sufficiently established.

Hitherto incandescent lighting has been successfully accomplished only at small distances from the generator, with enormous currents of low potential carried and distributed by conductors of proportionate size and cost. Applicants' aim was to use, if possible, currents of high potential carried to great distances, as gas is carried, and locally translated into light over conductors rivaling in economy and efficiency those used in arc lighting. This, if practicable, must be admitted to be a most important and meritorious achievement, fully worthy of protection, however simple and obvious after the fact. The inventors, who are aliens, aver that the scheme is not only practicable, but has been fully reduced to successful practice in foreign countries.

Their improvement consists in a combination of four elements, all belonging to the ordinary resources of the electrician, as much so as cams, gears and shafting to the mechanic, viz.: (1) A dynamo-electric generator of the ordinary type for furnishing currents of alternating polarity but high potential; (2) a primary circuit of any length for conveying this current of high potential; (3) an induction apparatus or series of such for furnishing a secondary current or currents of low potential induced

by the high potential primary ; these may be locally multiplied to any extent ; and (4) proper translating devices, which in this case are incandescent lamps in multiple arc, at the required localities. This is the whole apparatus, and applicants claim it to be new as well as useful and important.

The references illustrate the prior state of the art. The patent of Maiche, No. 243,454, is the earliest, and shows in combination (1) a battery or generator of a continuous current of quantity and low potential ; (2) a circuit-breaking rheotome for throwing the battery current into pulsations ; (3) an ordinary induction coil for converting the battery low potential pulsatory current into a high tension induced current capable of overcoming the resistance of a long line ; and (4) local reversed induction apparatus for taking off induced pulsatory currents of low potential for operating local telegraph sounders ; the object being to work the local receivers by a line wire current of high tension. This device differs from that of applicants, both in purpose and in structure. The difference consists in a primary pulsatory current of low potential in place of a current of alternating polarity and high potential, the said primary current being used merely to induce the line current of high potential instead of being itself the high potential line current needed. This difference is not merely one of comparative simplicity in favor of applicants' device, but one of practical utility for their purpose, since the low tension battery current and rheotome could not be used for electric lighting by reason of the loss of energy and material at the rheotome when produced on a scale competent for electric lighting purposes.

The second reference is the lecture-room experiment of Spottiswoode, described in "The Engineer," 1882. This approaches applicants' device in the use of a dynamo-generator giving currents of alternating polarity directly. These currents are, however, of low potential, and are used in the ordinary induction coil for producing high tension induced currents for performing electrical experiments. The device obviously could not be used for electric lighting : (1) because the primary alternating current is not of sufficiently high tension to traverse any great length of line wire ; (2) because if the secondary circuit be used as a line wire there are no translating devices whatever of low potential at the end, such as are needed for incandescent lighting, and

none are suggested. The device in fact does not have the reverse inductorium in conjunction with a high potential primary current of alternating polarity, the essential feature of applicants' device.

The third reference, viz., the patent of Edison, No. 278,418, is by far the most pertinent, and is also designed for the same purpose as applicants'. This device employs a dynamo-generator giving a continuous direct current of high potential as a line current. In order to get out of this the required induced local currents of low potential, Edison introduced local rotary commutators driven by power, which produced local pulsatory currents. The rotary commutators have the disadvantage, not only of requiring local power to drive them, but of consuming power and material by the inevitable "sparking" which takes place, their defect being that of a rheotome, and the more apparent by reason of the high tension currents used.

The merit of applicants' device may be thus summed up: They generate high tension currents of alternating polarity directly, thus getting a high tension line current with moderate-sized conductors, capable of acting upon the induction apparatus without the interposition of any rheotome, commutators or other devices for wasting energy and destroying plant. This they translate directly into the low tension currents required without the use of power or any apparatus except the local inductoriums. The changes over existing devices may seem simple and obvious after the fact, but this is a charge often brought against the most meritorious inventions, the telegraph and the speaking telephone not being exceptions. In the two latter conspicuous instances the Courts have so far found invention in the light of the vastly important results, and we do not hesitate to find invention in this case.

We come now to the consideration of the claims. These all relate, or are designed to relate, to the same substantial combination above discussed, which is really an improvement in the art of distributing electric currents for incandescent lighting as embodied in a practical apparatus.

Claim 1 relates to the combination of a reversed inductorium and a dynamo-electric generator producing currents of alternating polarity. It omits the translating devices, and therefore stops short of function. It seems to turn upon the immaterial

construction of the reversed inductorium in regard to relative lengths of conductor coils found in it rather than to the essential matter of the efficient combination—that is, (1) the generator giving high tension currents of alternate polarity and equal potential; (2) the reversed inductorium however constructed; (3) the primary high tension line circuit; and (4) the secondary low tension induction circuit with the translating devices.

Claim 2 is the same as claim 1, except that it describes the inductorium by its relative resistances instead of relative lengths of conductors, both immaterial points, the true point being the reversed inductorium, however constructed in its functional combination.

Claim 3 sets out the functional combination with some proximity regarding the reversed inductorium.

Claim 4 sets out the functional combination in its true order by functions, omitting the translating devices, which are essential to the efficient combination.

Claim 5 sets out the functional combination, but omits the essential point that the primary alternating currents must be of relatively high as well as of equal potential, and the secondary currents must be of low tension. The above claims would all be admissible, as various statements of the same substantial combination with changes as above suggested. A claim would also be admissible drawn with reference to the four essential elements as given in the above analysis. It is understood that a claim to the method was also made, and is now pending in a separate division. This claim, if found patentable, and it is still desired to patent it in a separate division, should be identified with this division by the proper cross references and go to patent simultaneously with it, as per *Holt, ex parte* (29 O. G., 171).

Upon the grounds of rejection raised by the Examiner, viz., want of patentable invention and anticipation by the references cited, we must reverse the Examiner's decision.

H. H BATES, } Exrs.-in-Chief.
R. L. B CLARK, }

[3d member absent.]

Washington, D. C., Sept. 14, 1886.

[10634]

[From the *Electrician and Electrical Engineer*, New York,
November, 1886.]

A NEW ERA IN DOMESTIC ELECTRIC LIGHTING.

When in the early part of 1880 the announcement was made, apparently upon good authority, that the electric light for domestic use was "at last a scientific and practical success;" that with all its obvious advantages, it could nevertheless be furnished to the consumer at a price less than that charged for gas, and that systems of incandescent electric lighting from central stations were to be forthwith established in all our large cities; it was generally believed by the public to mark the beginning of a new departure in domestic illumination. While we will not undertake to gain-say that in a certain sense this was true, yet in common with other more or less conservative electricians, we were by no means so sanguine as to the prospect, from a dollars and cents point of view, as were most of the promoters and capitalists connected with the new lighting enterprises. A very simple calculation sufficed to show that the real problem in domestic or house-to-house lighting, was simply one of cost rather than of possibility of distribution; that this had, as yet, received but a partial solution, and that unless the financial question thus raised could be successfully disposed of, the contest for supremacy as between gas and electricity must, purely for commercial reasons, ultimately terminate in a victory for the old illuminant. In seeming disregard of these considerations, however, several central station plants on a large and costly scale were erected, most of which have now been in continuous operation for some years. While it is claimed that some of them, the New York downtown district in particular, are earning a fair interest upon the capital invested, the fact that no apparent disposition exists to extend the sphere of operation to other and presumably more profitable sections of the city, points to a contrary conclusion, and one which more nearly coincides with the results of the computations of disinterested electrical engineers. The well understood limitations of existing central station systems, in respect to the practicable area of each district, which cannot be taken to exceed half a mile in any direction, as well as the excessive cost of the conductors necessary to effect a reasonable economy in distribution, have led many inventors to attempt to overcome these objections. The results of these attempts may be divided into three classes;—first, the multiple conductor system, of which the "Edison three-wire" is an example, which permits the working potential in the conductors to be increased, and the consequent weight of the conductors materially diminished; second, the storage system, in which accumulators are charged by high potential distribution current and discharged by a low potential consumption current, and third, the induction system, in which a current of high potential is employed in the mains, and converted into a current of low potential by inductive devices

situated at the places of consumption. The first of these plans somewhat diminished the cost of conductors, and so far as it did this was unquestionably an improvement. The second, for well understood reasons, has proved but partially successful, but the third, which has been for a number of years in process of evolution, appears at the present moment, in view of practical experiments and extended tests on a large scale, to be completely successful. Although but little has been made public respecting the results obtained with the improved apparatus now employed, yet the matter has already excited a remarkable degree of interest and inquiry in electrical circles. The originators of the inductive system have but just received their United States patent, the claims of which we reprint in another column, which will serve to show the fundamental principles of the system. It is almost needless to point out that if the inductive system proves to be practically successful, a result which we now see no reason to doubt, it is scarcely too much to say, that the problem of economical distribution over any area required in practice in electric lighting has received a final solution. If this turns out to be the case, the displacement of the existing illuminating gas plants by the new incandescent electric system can be at the utmost but a question of a few years time.

[From the *Pittsburg Dispatch*, October 31, 1886.]

A meeting of the Board of Directors of the Westinghouse Electric Light Co. was held yesterday afternoon to transact business connected with the enlargement of their plant. Owing to the rapid increase of their orders for electric lighting plants for cities and towns, the board are already considering still greater enlargements than even these arranged for a couple of months ago. The company, notwithstanding the fact that they have been considerably hampered for the past year for want of room and inability to get skilled electricians, have, within the past few months, put in 1,000 light plants at Trenton and Plainfield, N. J., Keokuk, Ia., Oswego, N. Y., and several others, and have now orders on hand for plants from a dozen to 20 towns and cities, and branch establishments will be put in at Chicago or St. Louis for supplying the northwest and southwest. The new patent granted Mr. Westinghouse at Washington on October 26, came up for discussion, but caused no action.

Mr. Westinghouse in speaking of the patents yesterday said: "The telegram printed in the *Dispatch* this morning is correct with the exception of some of the technical details. The patent grants to the Westinghouse Electric Light Co. that which illuminating gas companies, both here and in Europe, so greatly feared when Edison's experiments were so prominently before the public. A veritable revolution in lighting must necessarily follow, as we have perfected plans for its introduction into every city

and borough in the United States. Illuminating gas with its discomforts and disadvantages must now become a thing of the past, and adequate light can be had at a fair cost.

"The advantages in the cost of the plant are understated in your despatch of this morning. Instead of five per cent., as compared with the ordinary three-wire system for the copper wire main, there will be required less than one per cent. by the new system, and this holds good when both are operated with the same percentage of loss in the lines. A more striking illustration of this advantage is contained in the fact that the cost of copper wire for each 16 c. p. lamp, by the 'three-wire system,' is \$150 for a distance of four miles, while by the new system this cost is only \$1.50. And instead of 850 lamps, as stated in the despatch, there were 1,000 lamps lighted to their full candle power on a six mile circuit, the lamps being three miles from the dynamos; the current was carried by a copper wire main less than one-quarter of an inch in diameter; and, for each indicated horse-power of the engine, a fraction of over eight lamps of 16 c. p. each was obtained. Furthermore the armature for a machine capable of producing a current for 1 000 such lights, requires in its construction only 30 pounds of copper wire, while for the Thomson-Houston armature, having only one-quarter of this capacity, 225 pounds of copper wire are necessary.

"By this new system two dynamos driven by separate engines are made to deliver their currents to the same wire. This is accomplished perfectly and with the most simple expedients. Without the slightest interruption or inconvenience to the service, the dynamos can be connected or disconnected at pleasure, and the power regulated so that even nine-tenths of the lights may be cut off or put on without affecting the remaining ones; and at the same time a small switch, which would be capable of turning off only 30 small lamps of the old plan, easily cuts off the entire current of the main wire by the new system. Eminent electricians have long considered it impracticable, if not impossible, to successfully deliver to the same wire alternate currents from two or more dynamos, driven by separate engines. It is now accomplished and in the most perfect manner. This system involves the use of alternate high pressure currents, the alternations being at the rate of 15,000 per minute, which are locally reconverted into low pressure currents, so capable of modification that the lights can be turned up or down, as may be desired.

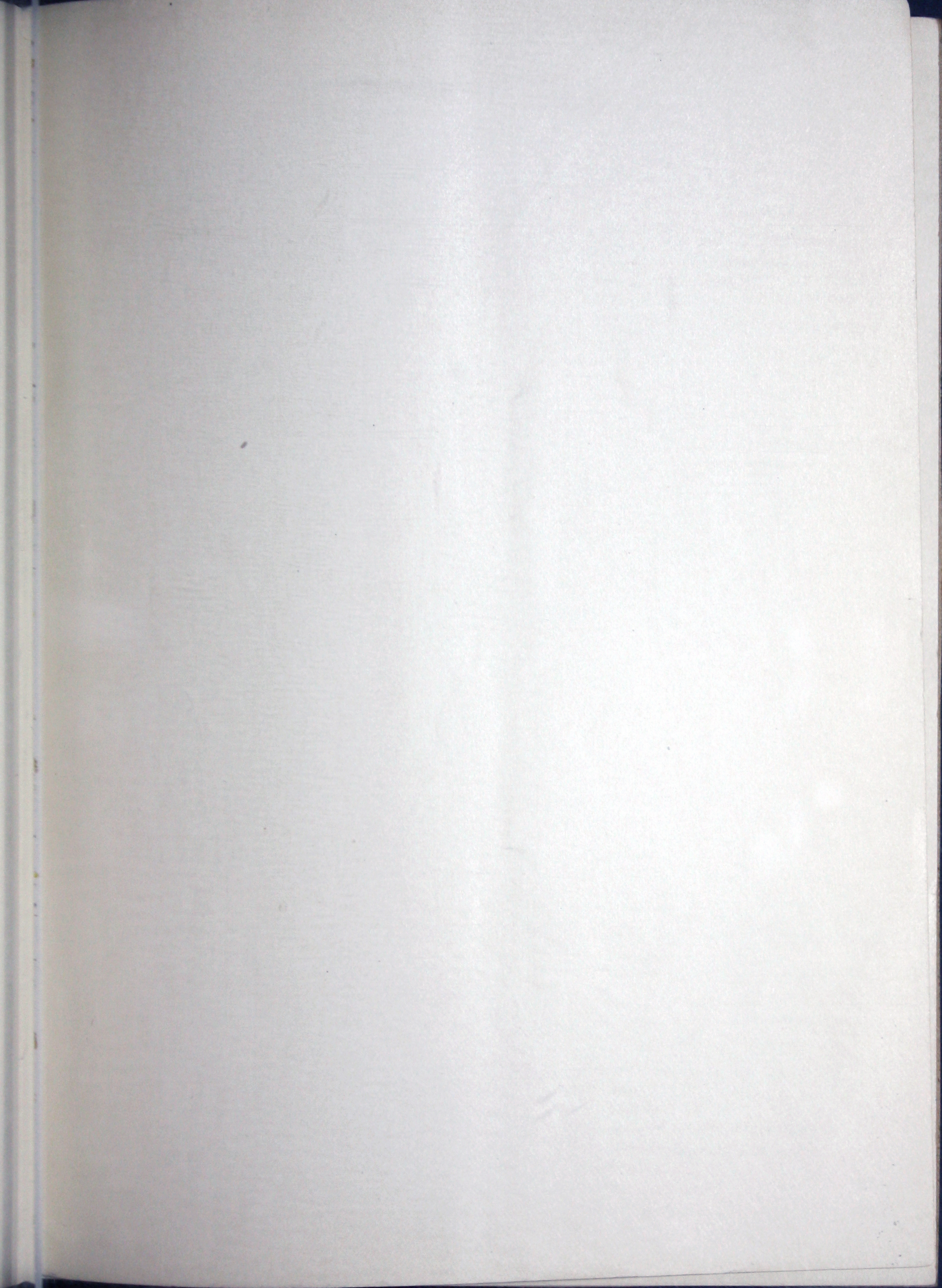
"This system is the result of a series of patient and, I may add, costly experiments which have been quietly carried on in this city for the past two years by the Westinghouse Electric Co., and which have but just been perfected. Another benefit in the system arises from the fact that it is no longer necessary to locate electric light plants near the centre of illumination, where property is always costly, and where the noise of machinery is more or less objectionable. They may now be located in the outskirts or farther away, where steam power may be cheaply produced or

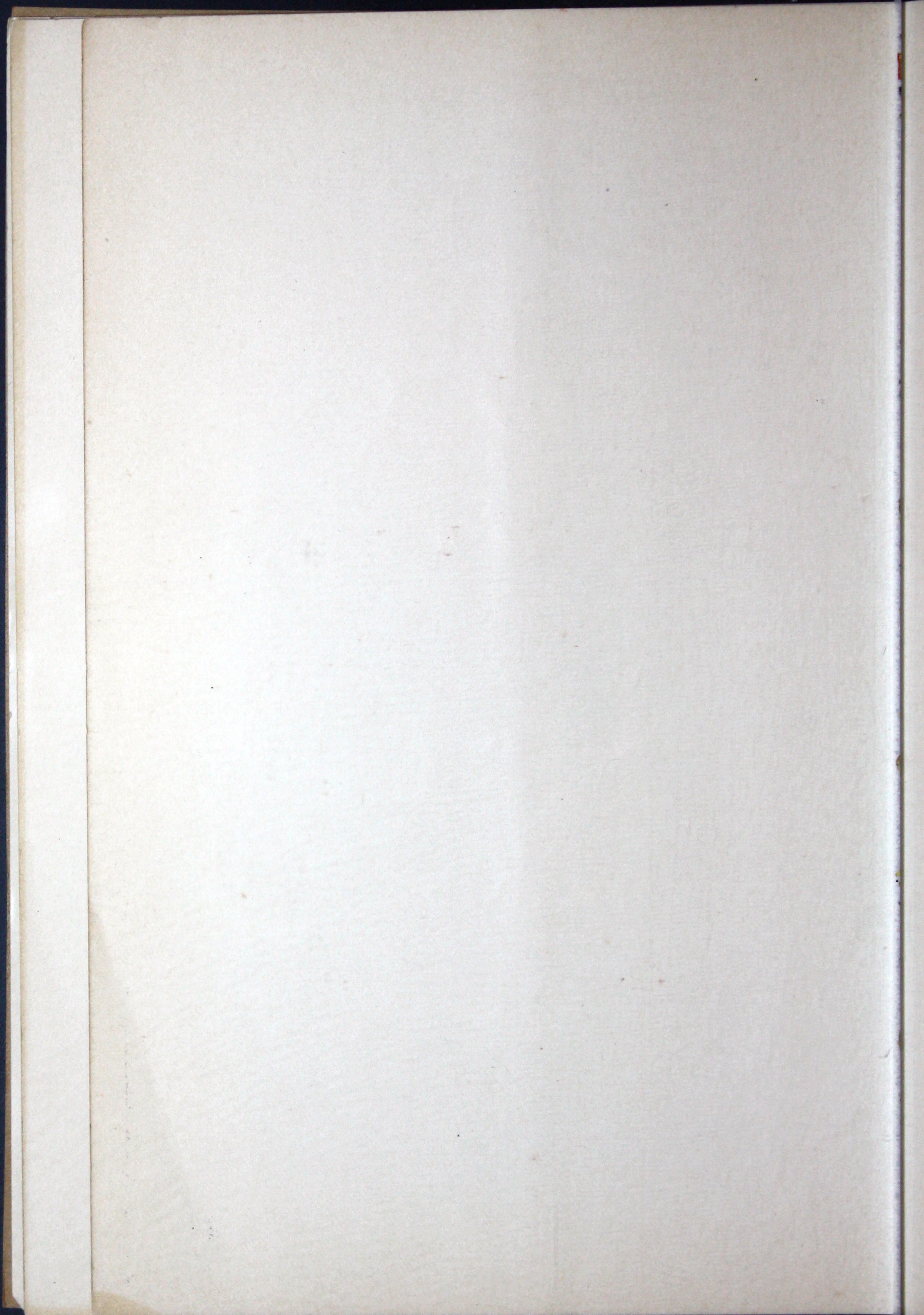
water power made available, or may be placed on a part of the property occupied by the plants of illuminating gas companies."

[From the *Philadelphia Inquirer*, November 1, 1886.]

The march of improvement which is so steadily and surely going on in our country seems to have brought forth at an opportune moment a new factor in the problem of light which will lead to an easy and very acceptable solution of it. The *Pittsburg Dispatch* of October 28 publishes an account of a new system of electric lighting for houses and general use, recently discovered and perfected by Mr. George Westinghouse, Jr., and his assistants, after patient and costly experiments, that have been quietly pursued by them for more than two years, an account of which we publish elsewhere.

It will not be questioned that on the same basis of cost and convenience in use, electricity would be universally preferred to gas for an illuminant. Indeed, on such a basis electricity would present great advantages over gas by affording a better light, and avoiding the dissemination of unhealthy products of combustion which are emitted by every gas flame; by averting altogether the damage to pictures, drapery, furniture, &c., from smoke and dirt, and by doing away with the discomforts of heat, which in the use of gas is often quite insufferable. It appears that all of these advantages can now be realized, and that the new era of adequate and perfect illumination by electricity, costing even less than gas, is now upon us. If this be so, and it seems to admit of no question, the people will have electricity for an illuminant. But such a revolution will not by any means necessarily depreciate the value of the gas works. They can be readily utilized for manufacturing and distributing a gas for heating purposes, and we will thus secure benefits scarcely less important on the side of health and comfort than those conferred by electricity, and of far greater importance in an economic sense in stimulating and sustaining our manufacturing industries in competition with other centres that are specially favored in having a supply of natural gas. Gas for fuel, as compared with coal, is an advance quite equal to that of electricity for light, as compared with gas. And this would seem to be but another demonstration of the fact that great improvements keep abreast of each other in the march of civilization.







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